Highlights

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Washington SCIENCE TRENDS

Orbital Refueling Plans

Air Force is working on plans for large satellite "gasoline stations" which would orbit the earth at an altitude of 200 miles carrying fuel supplies for military space vehicles. Probable capacity is estimated at one million pounds for a 75-foot diameter structure.

Investigations at Wright Air Development Center, Ohio have centered upon the difficulties of storing low boiling point or cyrogenic propellants in space for extended time intervals. Details are disclosed in a WADC technical report released for industrial use this week.

Air Force researchers considered possible evaporation losses in a multiple-layer, spherical liquid hydrogen container located in an equatorial earth orbit. Radiative heat loads from the sun and earth were considered in relation to the size of the orbital storage stations and the number of reflective shielding layers employed. Analysis indicated that the yearly fuel loss can be maintained below an "acceptable" five percent if sufficient reflective layers are employed. Further research is suggested on light-weight structures for such applications, and upon possible effects of meteorite puncture and deterioration.

Rapid Orbital Determinations

National Aeronautics and Space Administration (NASA) will soon announce that its theoretical division has developed a new method for determining orbit of a satellite from a single pass. Technique, using radar data, is expected to take five minutes for computation compared to 85 to 105 minutes at present. Here is a three-step method developed for Project Mercury:

* Orbital Plane -- a pair of points is selected at beginning and end of the pass and a plane is passed through these two points and center of the earth. Plane of the orbit is now determined.
* Orbital Elements -- A third point in the middle of the pass is added to first two. These three points are then used to determine the three orbital elements in the plane; period, perigee and position of perigee.
* Data Use -- Basic method is designed for three data points. For improved accuracy, several combinations of data triplets are chosen from the complete set of data constituting the pass, and orbit is determined for each triplet. Final orbit elements are derived from an average of individual results.
* Error -- in theoretical results errors have been less than a mile in perigee altitude; less than half a degree in perigee position and less than six minutes in period.

HIGH-TEMPERATURE RESEARCH

National Bureau of Standards plans a significant increase in its program for attaining, maintaining and measuring very high temperatures. The projects have important applications in space and atomic technology and other fields. Of particular interest is new work in ultra high temperatures where matter exists only in a gaseous form.

These programs bear watching:

Production and Measurement of Very High Temperatures -- NBS has constructed and installed a high current arc with which temperatures of some 15,000 °C. have been achieved and measured approximately. In another program, optical pyrometers can be calibrated at extended ranges through the use of zirconia and carbon arcs. Improvements in the NBS temperature scale between 1,063°C and 2,400°C permit more accurate development of such devices as missile nose cones and rocket motors. An experimental model using photoelectric devices has been constructed which indicates that it is possible to build an instrument ten times more accurate than present equipment. Improvements are being made on iridium and rhodium thermocouples for measurement of streams of hot gases up to 2,100°C.

Properties and Behavior of Materials -- New equipment is being constructed for determination of the viscosity of molten materials and gases. Temperatures of 1,000°C to 2,000°C are contemplated. Solid-gas reactions ocurring at high temperatures in light element compounds such as aluminum, beryllium and magnesium oxides are being measured with a microbalance sensitive to weight changes of the order of one microgram. Such data are needed for evaluation of possible solid-fuel propellants for rockets. Work is now in progress on some of the more refractory oxide crystals in connection with high temperature studies on the elastic constants of inorganic solids. The melting points of aluminum and titanium oxides is being studied with a solar furnace. Other studies include heat capacity measurements and the phase relations of systems at high temperature.

Ultra High Temperatures -- NBS is constructing a small 100 kilowatt pulsating power supply for a high temperature gas source and is studying plans for a new ultra high temperature facility. It would be used to study the thermodynamic and transport properties of gases, interaction of hot gases and solid walls and heat transfer from hot gases to solid materials. Investigations are also planned of the problems of establishing equilibriums in plasmas.

Molecular Beam Techniques -- NBS will attempt to apply molecular beam techniques to calorimetry to provide a possibly radical new tool for measurement of heat of vaporization, dissociation and chemical reactions of small amounts of material. The work would involve development of high-temperature techniques to generate molecular beams and low-temperature techniques for energy measurement.

Extreme Temperature Spectroscopy -- A new program will study the spectra of atoms and molecules significant to the kinetic processes involved in flames and hot gases, upper atmosphere phenomena and astrophysical environments. Results expected include systematic determination of data on electronic molecular spectra which are presently either largely unavailable or incomplete and spectrum line intensities required for development of standards and methods of temperature measurement in hot gases.

RESEARCH CHECKLIST

Here is the full text of the new or revised inventions sought by the Armed Forces as released by the National Inventors Council. Readers who may not have sent for the previous listing may obtain one without charge by writing NIC, U.S. Department of Commerce, Washington, D.C. Ask for "Technical Problems Affecting National Defense -- Basic List."

( ) Controllable Lift Device -- A controllable lift device to permit the slow descent of a man from an air vehicle to the earth. The device should be usable either in conjunction with a small stabilizing parachute or in lieu of any parachute. Should be capable of activation or deactivation as desired by the wearer. The device must provide excellent stability and be sufficiently responsive to control that the wearer may use it to assist in his movement over rough terrain while carrying normal combat equipment of the Infantry. Temperatures ranging from -65°F to +120°F should produce no effect upon the performance of the controllable lift device.

( ) Angle of Attack -- A mechanism to measure angle of attack at hypersonic speeds. It must operate at high temperatures and in the fringe of the earth's atmosphere.

( ) Altimeters -- Pressure sensitive mechanisms for measuring pressure altitude to 500,000 feet or higher. Must be simple and generally suitable for installation on aircraft.

( ) Trailing Aerodynamic Decelerator -- A trailing aerodynamic decelerator having high drag area to bulk and drag area to weight ratios, to decelerate air vehicles with initial hypersonic velocity in combination with very low air density. The decelerator must be capable of being stored within as small a volume as possible, must be designed for forcible and reliable deployment and extension, must exhibit excellent stability characteristics, and must operate at temperatures in the order of 1800°F without appreciable loss in strength. A capability to change the drag area of the decelerator, while deployed, within a ratio of 100 to 1 is desired.

( ) Precision Winds Measured by Ascending Rocket -- Determine wind speed up to 100,000 feet or at least 60,000 feet with an accuracy of one to two miles per hour during the ascent of a small rocket.

( ) Automatic Cloud Droplet Size Measuring Equipment -- One method to determine the drop size distribution in clouds is to collect the droplet on a slide, micro-photograph it, and count the droplets of different size ranges. This counting is a very time-consuming procedure. Therefore, an automatic or semi-automatic device to carry out this task would be extremely helpful.

( ) Continuous Cloud Droplet Size Measurement -- Droplet sizes in clouds range from 1 micron to 100 micron radius with concentrations from 10 to several 100 cc. A good method does not exist to measure the droplet size distribution from aircraft or from a balloon-borne device.

( ) Particulate Sampler -- A sampling device or set of samplers that can be used in the field to sample either liquid or solid particulates from a cloud of such material within discrete size ranges over a total range of 1 to 100 micron diameters. It would be desirable that the device sample as a function of time, either sequentially or continuously, although total sampling would be valuable.

( ) Wave Measurement Gage -- A device to measure the height of large water waves up to 75 feet as a function of time with an accuracy of one foot. Unit must be self-contained, not sensitive to shock, and capable of measurements in water of depths ranging from 25 to 2000 feet where the air space above the vicinity of the device is not accessible.

( ) Vibration Isolation Equipment -- Devices which will preclude deleterious effects to sensitive airborne equipment which must function properly in high "g" environments and under severe vibration conditions. High fidelity of data from the basic sensor is required without attenuation of performance due to use of vibration isolation device.

( ) Submarine Cable Repair -- Physically damaged submarine cables must be fished and brought to the surface for repair and splicing. A method is wanted which makes the damaged portion rise to surface by interaction with the sea water with internal chemicals when the damage occurs.

( ) Self-Restoral Submarine Cable -- A system whereby when a break occurs in a submarine cable, the section between repeaters will disconnect and the remaining repeater terminals will start producing sonic waves. A new cable section when put in the area with temporary sonic seeking torpedo type carriers will connect the two end repeaters with the new cable section to restore electrical signal transfer.

( ) Microbiological Food Production From Inedible Natural Sources -- During military action, individuals are often cut off from food supply channels. Under such conditions, the individual may not be able to carry sufficient rations to tide him over the survival period. "Living off the land" is his only alternative to starvation. This situation might confront military personnel as well as civilians in the event of atomic war. Needed therefore are methods for living off the land, as, for example, the use of microorganisms (yeasts, molds, bacteria) to transmute inedible materials into edible substances, or the application of metabolizers (such as exist in ruminants) to plant products that require pretreatment prior to being eaten by man. Within this same general area would come the development of a closed cyclical, biological system wherein microorganisms could be used to produce edible foods from cellulosic materials and waste.

( ) Pressure Sensing Devices -- A small size pressure sensor not dependent on bellows, diaphragms, or bourdon tubes, to provide an accurate indication of pressure in fluid lines and combustion areas.

( ) Data Transmitting Devices -- Devices which are accurate and repeatable to within 30 seconds of arc. Means are required to precisely transmit electrical signals from sensors to equipment, indicators, and subsystems utilized on weapons systems.

( ) Methods for Preventing the Hardening of Baked Products During Long-Term Storage -- Canned bread and other preserved bakery foods undergo texture staling at approximately the same rate as their conventional counterparts. Since Armed Forces' operational rations do not reach the consumer until many months after they have been prepared, the baked products in these rations reach an advanced stage of texture staling before they are eaten. The firmness resulting from staling causes rather low acceptability for these items. Addition of emulsifiers or other inhibitors of staling retards the process for only a few days. Revolutionary new approaches to the problem may be required in order to secure the long-term stability desired for operational rations.

( ) New and Better Compounds for Use as Fungicides in Military Material and Equipage -- No fungicide is available that is colorless, compatible with other components of a finish stable to chemical change and actinic radiation, resistant to leaching, is non-toxic to humans, and economical both with regards to effective concentrations and cost.

( ) Insect Repellents to Protect Personnel from Insect Attack -- While good protection against many species of insects is afforded for at least 6 hours by diethyltoluamide, this material does not permit full protection of a man over the normal sleeping period or the working day without re-application. A material or formulation is needed which will protect a man for at least 12 hours. Diethyltoluamide must be applied to clothing frequently if adequate control is to be obtained. A repellent is needed which can be applied during the manufacture of the clothing and which will last the life of the garment. Current repellents repel primarily by contact action. So-called "space repellents" which will work in the vapor phase to drive insects well away from personnel or completely out of a military operational area in order to prevent the reduction of efficiency in personnel, which is caused by the nuisance character of these insects, are needed. Current methods of testing chemicals for possible repellent action are costly, tedious, and relatively inaccurate. New methods must be developed to overcome these handicaps.

( ) A Reusable Photographic Storage Medium -- A reusable photographic storage medium incorporating resolution comparable to finest grain photo material; sensitivity comparable to fast photo material; processing as easy as magnetic tape, and with a visible image on a flexible support.

( ) Preformed Semiconductor Crystals for Device Fabrication -- Germanium and silicon single crystals grown in ribbons or rods with uniform physical and electrical characteristics to the sizes suitable for direct fabrication into diodes, transistors, solar cells, etc. The semiconductor material should have the properties equal to or superior to material presently used in germanium and silicon transistors. The new growing method should permit the direct utilization of the semiconductor for device fabrication thus eliminating the conventional wasteful and expensive slicing, lapping, and polishing operations.

( ) Reliable Long Life Cathode -- An efficient, indirectly heated, unipotential thermionic cathode having 100,000 hours' life in negative grid tube with current density of 500 mAdc/cm2.

( ) A Dry Battery Performance Capability Indicator -- A material in the form of a sheet or strip which in aging changes colors or textures, or colors and textures, through a spectrum of colors and textures. The desired change indication should be brought about by the same ambient conditions that influence the deterioration of performance capability in dry batteries and the indications under the influencing ambient conditions should proceed at the same rate as the deterioration of performance capability proceeds in dry batteries.

( ) Carbon Black Evaluation -- A test precedure or device whereby the suitability of a lot of carbon black, for use in dry batteries, may be determined quickly and inexpensively.

( ) Resistance Thermometer -- A material having a high temperature coefficient of resistance which can be drawn or formed into filament so that a resistance thermometer having physical characteristics of a platinum resistance thermometer be constructed which has a large resistance change such as possessed by thermistors.

( ) Techniques for Incorporating Additives to Soils -- New concepts for mixing a soil stabilizer into wet sticky soils. Present techniques require either extremely cumbersome machinery or are inefficient or both. Concept must be capable to being utilized by lightweight, highly mobile equipment and must be able to achieve an intimate blend of soil with either a dry powder or a liquid. It is desirable to be able to accomplish stabilizer incorporation rapidly to depths as great as two feet with a minimum of manipulation of the soil.

Also:

( ) Low Loss, High Power Ferrites for Use as Microwave Phase Shifter.

( ) A Broadband Maser Amplifier for Use in Microwave Region.

( ) A New Method of Electronically (Not with Frequency Change) Scanning an Antenna.

The following revised problems were released:

( ) Plastic Laminates -- Plastic laminates for airplane landing mats with the following physical characteristics: (a) 60,000 psi flexure strength, (b) 50,000 psi compresive and tensile yield, and (c) modulus of elasticity in the range of 3,000,000 to 5,000,000 psi. If possible, the laminates should be capable of being formed with low pressure techniques.

( ) Dry Battery Test Method -- Two Problems -- (a) An Accelerated Dry Battery MnO_2 Evaluation Procedure -- An accelerated procedure for evaluating manganese dioxide for use in dry batteries. (b) An Accelerated Dry Battery Evaluation Procedure -- An Accelerated test method which will indicate quality and shelf life of dry batteries.

( ) Freezing Point Measurement Method -- A compact, accurate, rapid method for determining the freezing point of coolants in military equipment during Arctic operation. Equipment now in use is cumbersome and requires technical personnel to operate it. The desired equipment should be as easy to use as the conventional automotive hydrometer but of improved accuracy.

( ) Controllable Range Droplet Dispenser -- A droplet generator or disperser which will operate without heating the liquid significantly above ambient temperatures. The device should yield large quantities of monodisperse droplet at controllable rates and in controllable ranges from 1 to 100 micron diameters. The device would be used to fill chambers and/or wind tunnels with liquid particulates of a known droplet size.

( ) Water Pressure-Time Gage -- A simple, inexpensive, accurate mechanical gage for reliable recording of the pressure-time history of a water shock. The gage is intended for field use and should be self-contained. The pressure sensing and recording mechanisms must be insensitive to shock so that the pressure record will not be obscured. Operating depths extend to 200 feet, and shock pressures range from 200 to 15,000 psi.

NASA Space Boosters

NASA is reshuffling its space booster program and delaying some planned firings until new vehicles are available. Administrator T. Keith Glennan tells Congress that with new Vegas, Deltas and Centaurs "we will get more weight into orbit and space more cheaply and more efficiently than heretofore."

Cutback - NASA is cutting back planned procurement of Army-Chrysler Juno II vehicles from 8 to 5. No Thor-Ables will be procured as such. Instead, 12 Thor-Deltas have been ordered, which are essentially Thor-Ables with the addition of a coasting guidance system for general satellite and space probe work.

Centaur vehicles being ordered are expected to be capable of placing more than 8,000 pounds in a 300-mile orbit or soft-landing a 730 pound scientific payload on the Moon. Centaur consists of a modified Atlas ICBM as first stage, a very high energy second stage and a 6,000 pound thrust third stage, now being developed.

Vega vehicles consist of a modified Atlas as first stage, a modified Vanguard first stage as second stage, and the same third stage is in the Centaur. Eight are being ordered. Vehicles are said to be capable of placing more than 5,000 pounds in an Earth orbit and will be one of the first space vehicles capable of making extensive television surveys of the Moon's surface. Vegas will also permit "significant" communications relay satellite experiments and two-man satellites.

Firing Schedule -- Tentative plans call for NASA to start firing Deltas in late 1959, Vegas near the middle of 1960 and Centaurs early in 1961.

Costs -- Glennan estimates costs for a payload in a 300 mile orbit. Juno II can handle about 80 pounds at about $15,000 per pound. Delta can carry 250 pounds at $5,000 per pound and Vegas can carry 6,000 pounds at $600 per pound. For deep space probes Juno II's payload costs $100,000 per pound; Delta's costs $50,000 per pound and Vega's will cost $3,200 per pound.

SPACE SCIENCES -- NASA has just made public an excellent April, 1959 summary of its space science programs in a number of fields. Subscribers desiring a copy may write to Service Department, Washington SCIENCE TRENDS, 1120 National Press Building, Washington 4, D.C. No charge.

PUBLICATIONS CHECKLIST

( ) Automation: Its Impact on Business and Labor, an excellent survey by John Diebold covering automation in practice, and economic and social implications. 64 pages. $1. (Write Publication Office, National Planning Association, 1606 New Hampshire Avenue, N.W. Washington 9,D.C.)

( ) Psychopharmacology, the papers and proceedings of a 1956 conference on the Evaluation of Pharmacotherapy in Mental Illness. Just Published. 662 pages. $6.50. (Write Printing and Publishing Office, National Academy of Sciences, 2101 Constitution Avenue, Washington 25, D.C.)

( ) Chromite, a discussion of rapid methods of laboratory analysis for determination of the major and some minor constituents of chromite and chromite ore. 37 pages. 20 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for Publication No. I 19.3:1084-B)

( ) Radiation, a compilation of information on the radiations from radioactive atoms in frequent use. Designed particularly for workers in the biological and medical sciences who are concerned with estimations and calculations of dose. 75 pages. 55 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for Pub. No. Y 3 AT 7:2 R 11/22)

( ) Defense Procurement, a new handbook of procurement information on guided missile programs, rockets and target drones. Presents unclassified information of interest to individuals, groups or firms seeking prime contracts or subcontracts. Includes listing of Army, Navy and Air Force missile and rocket systems and prime contractors. 28 pages. 15 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for Pub. No. D 7.2:M 69)

( ) Physical Security, a new army field manual for military installations and industrial installations under military management. May also serve as a guide in determining physical security measures required for private facilities under army cognizance. 179 pages. 55 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for Pub. No. D 101.20:19-30/2)

( ) Glass Apparatus, a guide containing specifications and tolerances for glass volumetric apparatus of the precision grade. A description of test methods used and the reports furnished and directions for submitting apparatus are included. 14 pages. 20 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for Pub. No. C 13.4:602)

( ) Mica, a study of synthetic fluorphlogopite mica as developed by the U.S. Bureau of Mines. Thermodynamic data having application both in the production and use of this product is included. 16 pages. 20 cents. (Write Superintendent of Documents, Government Printing Office, Washington 25, D.C. for Pub. No. I 28.23:5436)

( ) Ion and Plasma Research, abstracts of papers presented at a 1958 conference on these subjects sponsored by the Air Research and Development Command at the University of Maryland. 73 pages. $2. (Write OTS, U.S. Department of Commerce, Washington 25, D.C. for PB 151 316)